# Rearranging algebraic expressions

Introduction

Mathcad can help with many basic algebraic operations by working symbolically, that is manipulating expressions which contain symbols as well as numbers.

MST121

Preparing to work symbolically
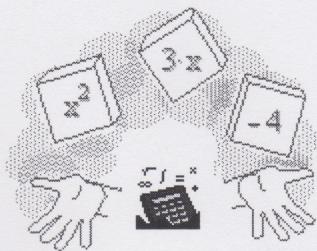
The tools for manipulating algebraic expressions are provided by Mathcad's symbolic processor, using commands from the **Symbolic** menu. Before using any of these commands you must first load the symbolic processor.

▶   Choose **Load Symbolic Processor** from the bottom of the **Symbolic** menu.

There will be a short delay while loading takes place.
(Note that the mouse arrow changes into a maple leaf during loading.)

Once the symbolic processor has been loaded this 'load' command will disappear from the menu.

The symbolic processor now remains available for use until you exit from Mathcad.

You can control how the results of symbolic calculations are displayed. To do this :

▶   Choose **Derivation Format...** from the **Symbolic** menu.

    Click in the check box to **Show derivation comments**
    and select the option button to show the derivation steps **horizontally** before clicking **OK** .

It is not strictly necessary to the process for Mathcad to insert these derivation comments, but they help to make what's going on a little clearer, as you will see.

Now you are ready to simplify, expand and factorise the expressions on the following pages.

4.1 (a) $(a - 2 \cdot b + 3 \cdot c - 4 \cdot d) - (-4 \cdot a + 3 \cdot b - 2 \cdot c + d)$

To **simplify** the expression above, use the following procedure :

▷ Click anywhere on the expression <u>above</u>.
Press 'Up Arrow' [↑] until the selection box surrounds the entire expression like this -
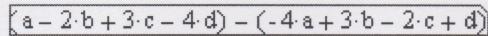
$$\boxed{(a - 2 \cdot b + 3 \cdot c - 4 \cdot d) - (-4 \cdot a + 3 \cdot b - 2 \cdot c + d)}$$

▷ Then choose **<u>Simplify</u>** from the **Symbolic** menu.

After a short pause Mathcad should display ....   simplifies to $5 \cdot a - 5 \cdot b + 5 \cdot c - 5 \cdot d$

If not, see the first comment provided at the bottom of this page.

Please scroll down for two more expressions to simplify.
(Note that the labelling of the expressions refers to Activity 4.1 in Chapter A0.)

▷ Once again select the entire expression, by clicking on it and pressing 'Up Arrow' [↑].
Then choose **<u>Simplify</u>** from the **Symbolic** menu.

(b) $\dfrac{20 \cdot a^2 \cdot b}{15 \cdot a \cdot b^2}$

(e) $\dfrac{4}{3 \cdot (x + 2)} + \dfrac{2}{x + 3}$

Comments

▤ If the 'Simplify' option is unavailable from the Symbolic menu, make sure that you have loaded the symbolic processor. The result of the Mathcad simplification is shown below :

$(a - 2 \cdot b + 3 \cdot c - 4 \cdot d) - (-4 \cdot a + 3 \cdot b - 2 \cdot c + d)$ simplifies to $5 \cdot a - 5 \cdot b + 5 \cdot c - 5 \cdot d$

If Mathcad just reproduced the original expression, then make sure that the selection box is around the entire expression before choosing to simplify.

If you did not obtain Mathcad's derivation comment 'simplifies to' or the result appeared underneath the original expression, then check the 'Derivation Format' described on page 2.

▤ The other two simplified expressions you should have found are -

(b) $\dfrac{4}{3} \cdot \dfrac{a}{b}$ (e) $\dfrac{2}{3} \cdot \dfrac{(5 \cdot x + 12)}{((x + 2) \cdot (x + 3))}$

Note that the expression obtained for (e) contains some unnecessary extra brackets.

▤ Mathcad's 'Simplify' option performs several algebraic methods - it collects like terms, cancels common factors and performs simple arithmetic, to combine fractions for example.

If this option can't simplify an expression, then it will just return the original expression as the answer. Note too that computer algebra is not perfect, and on occasions you may think that the answer Mathcad produces is more complicated than the original !

Expanding algebraic expressions - Task 2

The procedure to **expand** expressions in Mathcad
is very similar to the one used to simplify expressions on the previous page.

4.1 (c) (i) $(x + 1) \cdot (x - 2)$

▶ Click anywhere on the expression <u>above</u>.
   Press 'Up Arrow' [↑] until the selection box surrounds the entire expression, like this -
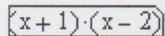
   $\boxed{(x + 1) \cdot (x - 2)}$

▶ Then choose **Expand Expression** from the **Symbolic** menu.

   After a short pause Mathcad should display ....   expands to $x^2 - x - 2$

Please scroll down for three more expressions to expand.

▶ Once again select the entire expression, by clicking on it and pressing 'Up Arrow' [↑].
   Then choose **Expand Expression** from the **Symbolic** menu.

(c) (ii) $(a - b)^2$

(c) (iii) $(t + 1) \cdot (t + 2) \cdot (t + 3)$

(f) $\dfrac{x^2 + 2 \cdot x + 1}{x^3}$

Comments

▦ Mathcad expands the three expressions above as follows -

   (c) (ii) $a^2 - 2 \cdot a \cdot b + b^2$ (c) (iii) $t^3 + 6 \cdot t^2 + 11 \cdot t + 6$ (f) $\dfrac{1}{x} + \dfrac{2}{x^2} + \dfrac{1}{x^3}$

▦ The 'Expand Expression' command expands all products and powers in an expression,
   so it can be used both to multiply out brackets and to expand a fraction.

To **factorise** expressions in Mathcad, you once again need to select the entire expression within the blue selection box, then choose **Factor Expression** from the **Symbolic** menu.

▷ Have a go at entering and then factorising the three expressions below for yourself.

Help and **answers** are available at the bottom of the page.

Don't forget to enter all the multiplication signs when constructing these expressions in Mathcad !

4.1 (d) Factorise (i) $a^2b - ab^2$

(ii) $x^2 - 4$

(iii) $x^2 - 2x + 1$

Help

▨ The following keystrokes can be used to enter the three expressions.

$a^2 \cdot b - a \cdot b^2$ Type **a^2[↑][↑]*b-a*b^2**

$x^2 - 4$ **x^2[↑][↑]-4**

$x^2 - 2 \cdot x + 1$ **x^2[↑][↑]-2*x+1**

The multiplication signs must be entered between products in Mathcad ; for example, for 'two times x' type **2*x** not **2x**. Powers are given by the **^** key ([Shift]6). The expressions also require careful use of the 'Up Arrow' key [↑].

▨ To factorise an expression, click on it and press 'Up Arrow' [↑] until the selection box surrounds the entire expression, like this - $\boxed{a^2 \cdot b - a \cdot b^2}$
Then choose **Factor Expression** from the **Symbolic** menu.

Answers

▨ Here are the answers we obtained -

$a^2 \cdot b - a \cdot b^2$ by factoring, yields $a \cdot b \cdot (-b + a)$

$x^2 - 4$ by factoring, yields $(x - 2) \cdot (x + 2)$

$x^2 - 2 \cdot x + 1$ by factoring, yields $(x - 1)^2$

▨ Note that your first answer might differ slightly in appearance from the one shown here as Mathcad may express $-b + a$ in the more familiar order of $a - b$ on your computer - it is not possible to predict exactly what it will do !

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